Dramatic Decrease in the Incidence of *Salmonella* Serotype Enteritidis Infections in 5 FoodNet Sites: 1996–1999

Ruthanne Marcus,[1] Terry Rabatsky-Ehr,[1] Janet C. Mohle-Boetani,[2] Monica Farley,[3] Carlota Medus,[5] Beletshachew Shiferaw,[6] Michael Carter,[7] Shelley Zansky,[8] Malinda Kennedy,[4] Thomas Van Gilder,[4] and James L. Hadler,[1] for the Emerging Infections Program FoodNet Working Group[a]

[1]Connecticut Emerging Infections Program, New Haven and Hartford; [2]California Department of Health Services, Berkeley; [3]Emory University School of Medicine and [4]Foodborne and Diarrheal Diseases Branch, Division of Bacterial and Mycotic Diseases, National Center for Infectious Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia; [5]Minnesota Department of Health, Minneapolis; [6]Department of Human Services, Oregon Health Division, Portland; [7]Maryland Department of Health and Mental Hygiene, Baltimore; [8]New York State Department of Health, Albany

***Salmonella* serotype Enteritidis (SE) emerged as the most common *Salmonella* serotype among infected persons in the United States during the 1980s and 1990s, with infections reaching a peak in 1995. During the past decade, farm-to-table control measures have been instituted in the United States, particularly in regions with the highest incidence of SE infection. We report trends in the incidence of SE in the 5 original surveillance areas of the Foodborne Diseases Active Surveillance Network during 1996–1999: Minnesota, Oregon, and selected counties in California, Connecticut, and Georgia. Overall, the incidence of SE decreased 46% from 1996 to 1999. The greatest decrease was in Connecticut (71%), followed by northern California (50%), Minnesota (46%), and Oregon (13%). Although SE infection remains an important public health concern, there has been a remarkable decrease in its incidence. This decrease may be a result of targeted interventions, including on-farm control measures, refrigeration, and education efforts.**

In the United States, *Salmonella* infections are the second most common cause of bacterial foodborne illness, behind *Campylobacter* infections [1–3]. During 1994–1996, *Salmonella* serotype Enteritidis (SE) was the most frequently reported serotype of *Salmonella*, and it accounted for 22% of culture-confirmed *Salmonella* infections reported via national surveillance [4].

In the early 1980s, the incidence of infection with SE was higher in the northeastern United States than in other areas of the country [5, 6]. Since 1990, however, rates of infection have decreased in the northeast while increasing considerably in the west [6]. Information on incidence trends and sources of SE infections come from national, passive, public health laboratory–based surveillance systems and foodborne disease outbreak surveillance.

In 1995, the Centers for Disease Control and Prevention (CDC) and 5 state health departments, in collaboration with the Food Safety and Inspection Service of the US Department of Agriculture and the US Food and Drug Administration (FDA), established the Foodborne Diseases Active Surveillance Network (FoodNet) to determine more accurately the burden of foodborne illness in the United States and to gain a clearer understanding of the risk factors for foodborne illness and the reasons for differences in incidence rates [7]. FoodNet surveillance areas (also known as "FoodNet

Financial support: Centers for Disease Control and Prevention's National Center for Infectious Diseases; US Department of Agriculture, Food Safety and Inspection Service; US Food and Drug Administration, Center for Food Safety and Applied Nutrition.

[a] Working group members are listed at the end of the text.

Reprints or correspondence: Ms. Ruthanne Marcus, MPH Connecticut FoodNet Emerging Infections Program, 1 Church St., 7th Fl. New Haven CT 06510 (ruthanne.marcus@yale.edu).

Clinical Infectious Diseases 2004;38(Suppl 3):S135–41

1058-4838/2004/3805S3-0004$15.00

sites") are located in different parts of the United States, to provide insight into regional differences in rates of infection and to monitor trends over time. We report surveillance data for culture-confirmed cases of SE infection ascertained in the 5 original FoodNet sites during 1996–1999. We also present 1999 data from the entire 7-site FoodNet catchment area to show the burden of SE infection in the United States with greater precision.

MATERIALS AND METHODS

In 1996, the 5 FoodNet sites initiated active laboratory-based surveillance for culture-confirmed cases of infection with 7 bacterial foodborne pathogens, including *Salmonella* species. Surveillance was conducted in Minnesota and Oregon and in selected counties in California (Alameda and San Francisco), Connecticut (Hartford and New Haven), and Georgia (Clayton, Cobb, Dekalb, Douglas, Fulton, Gwinnett, Newton, and Rockdale). The total population under surveillance, according to the 1996 postcensus estimate, was 14,281,096. The 1999 postcensus estimate was 14,782,206 for the same catchment area. In 1997, the population of the catchment area increased to 16,110,250 with the addition of counties in Connecticut (Fairfield) and Georgia (Barrow, Bartow, Carroll, Cherokee, Coweta, Fayette, Forsyth, Henry, Paulding, Pickens, Spalding, and Walton). In 1998, the population increased to 20,723,982 with the addition of counties in Maryland (Anne Arundel, Baltimore City, Baltimore County, Carroll, Harford, and Howard) and New York (Genesee, Livingston, Monroe, Ontario, Orleans, Wayne, and Yates) and the extension of surveillance to the entire state of Connecticut. In 1999, the population increased to 25,859,311 with the addition of counties in New York (Albany, Columbia, Greene, Montgomery, Rensselaer, Saratoga, Schenectady, and Schoharie) and the extension of surveillance to the entire state of Georgia. We conducted trend analysis by comparing the rates in the original 5 FoodNet sites using postcensus estimates for 1996–1999 sites as denominators. We conducted the study in accordance with guidelines for human research as specified by the US Department of Health and Human Services.

All culture-confirmed cases of infection with *Salmonella* species were ascertained by the FoodNet surveillance system. Active surveillance included laboratory contact through visits or telephone calls at least monthly to ensure that all culture-confirmed cases were ascertained. The methods of surveillance used at each FoodNet site depended on the availability of computer-generated reports, the geographic feasibility of laboratory visits, and the accessibility of laboratory reports.

A standardized case-report form was used for all culture-confirmed cases of *Salmonella* infection. Data collected for each case included demographic information on the infected person (name, address, age or date of birth, sex, race/ethnicity, and county of residence), specimen information (date of specimen collection, source of specimen [e.g., stool or blood], and reporting laboratory), the status of the infected patient at the time of specimen collection (outpatient or inpatient), whether the patient was subsequently hospitalized, and the patient's outcome (alive or dead).

Reports of *Salmonella* isolated from urine were not included in surveillance before 1999. Since 1999, however, specimens from urine have been included. For this analysis, we excluded 1999 data on SE isolated from urine from our trend analysis but did include them in our analysis of 1999 data from all 7 sites.

Laboratory testing and serotyping. All clinical microbiology laboratories that received specimens from catchment area residents routinely culture all submitted stool specimens for *Salmonella* species. Laboratories are legally required to report any isolation of *Salmonella* species to the appropriate state public health department. In addition, clinical laboratories in Connecticut and Minnesota are required to forward all *Salmonella* isolates to the state public health laboratory for serotyping. In Georgia, Maryland, and New York, laboratories are asked but not required to forward *Salmonella* isolates; in California and Oregon, laboratories are required to send such isolates to the

Table 1. *Salmonella* serotype Enteritidis (SE) as a percentage of all *Salmonella* isolates serotyped, by site and year, from the 5 original FoodNet sites, 1996–1999.

	No. (%) of isolates, by year							
	1996		1997		1998		1999	
Site	Serotyped	Identified as SE	Serotyped	Identified as SE	Serotyped	Identified as SE	Serotyped	Identified as SE
California	356	59 (16)	341	42 (12)	322	29 (9)	295	31 (11)
Connecticut	279	128 (46)	280	116 (41)	203	56 (28)	236	37 (16)
Georgia	258	14 (5)	262	19 (7)	315	19 (6)	434	31 (7)
Minnesota	643	118 (18)	604	115 (19)	567	60 (11)	590	65 (11)
Oregon	375	39 (10)	325	37 (11)	294	41 (14)	386	35 (9)
Total	1911	358 (19)	1812	329 (18)	1701	205 (12)	1941	199 (10)

state laboratory if they do not perform serotyping themselves. State public health laboratories serotyped *Salmonella* isolates using the Kauffmann-White scheme [8].

Data analysis. Surveillance data were entered into the CDC Public Health Laboratory Information System at each site. Data, excluding patient identifiers, were transmitted electronically to CDC on a routine basis. Individual site data were compiled, aggregated, and analyzed at CDC with the use of SAS software, version 6.12 (SAS). We calculated SE infection rates using 1996, 1997, 1998, and 1999 postcensus population estimates from the US Bureau of the Census. To account for patients for whom we had no racial/ethnic identification, we adjusted infection rates among racial/ethnic groups by assuming that the racial/ethnic distribution among such patients was identical to that among patients for whom we did have data on race/ethnicity.

RESULTS

Trend during 1996–1999. During the period 1996–1999, FoodNet ascertained 7802 cases of infection with *Salmonella* species in the 5 original sites (in 1996, 2064 cases; in 1997, 1943 cases; in 1998, 1786 cases; and in 1999, 2009 cases). Of the 7365 *Salmonella* isolates that were serotyped, the proportion that were SE progressively decreased by 47% from 1996 to 1999, from 19% to 10% ($P < .05$, χ^2 for trend) (table 1). In 1996, the percentage of *Salmonella* isolates that were SE varied widely by state, from a high of 46% in Connecticut to a low of 5% in Georgia (table 1). Three states accounted for most of the cases overall and for most of the decrease from 1996 to 1999: Connecticut (from 46% to 16%; $P < 10^{-5}$, χ^2 for trend), Minnesota (from 18% to 11%, $P < 10^{-5}$), and California (from 16% to 11%, $P = .008$, χ^2 for trend).

The overall incidence of SE infections per 100,000 population decreased 46% during 1996–1999, from 2.5 to 1.3 (table 2). Incidences of SE infection varied by site and year, with the highest rate in Connecticut in 1996 (7.9) and the lowest rate in Georgia in 1996 (0.5). The decrease in incidence from 1996 to 1999 was greatest in Connecticut (71%). Rates also decreased in California (50%), Minnesota (46%), and Oregon (13%). Overall and annual rates were similar for male and female subjects; both decreased during the 4-year time period.

Examining the data by age group, we found that average annual rates of SE infection were highest among infants aged <1 year (3.9 cases/100,000 population) (table 2). Only in California, however, were rates of SE infection not highest among infants (figure 1). Rates decreased in all age groups from 1996 to 1999, although the decrease was generally not progressive within any given age group. The group aged 30–59 years had the biggest decrease (54%), and infants had the smallest decrease (15%).

Table 2. Incidence of *Salmonella* serotype Enteritidis infection, FoodNet, 1996–1999.

	Original 5 sites					All 7 sites,[a]
Variable	1996	1997	1998	1999	4-year mean	1999
By site						
California	2.9	2.0	1.4	1.4	1.9	1.4
Connecticut	7.9	7.2	3.5	2.3	5.2	3.3
Georgia	0.5	0.7	0.7	1.1	0.7	0.7
Minnesota	2.5	2.5	1.3	1.4	1.9	1.4
Oregon	1.2	1.1	1.2	1.1	1.2	1.1
Maryland	…	…	…	…	…	4.2
New York	…	…	…	…	…	1.0
All sites	2.5	2.3	1.4	1.3	1.9	1.6
By sex						
Male	2.5	2.2	1.3	1.4	1.8	1.6
Female	2.6	2.4	1.5	1.3	1.9	1.6
By age group, years						
<1	4.1	2.0	5.6	3.0	3.9	6.5
1–9	3.2	2.5	1.9	1.9	2.5	2.6
10–19	1.9	1.9	0.9	1.2	1.6	1.3
20–29	2.9	3.2	1.7	1.6	2.6	1.7
30–39	2.8	2.1	1.2	1.3	2.0	1.4
40–49	2.0	2.4	1.3	0.9	1.9	1.3
50–59	3.1	2.2	1.5	1.3	2.2	1.4
⩾60	1.8	1.8	1.1	1.2	1.6	1.4
By race (adjusted)						
White	2.6	2.2	1.5	1.3	1.9	1.6
Black	2.5	2.4	1.3	1.5	1.9	2.4
Hispanic	3.5	4.5	1.5	1.9	2.8	1.9
Asian	1.1	1.6	0.6	1.0	1.1	1.1
American Indian	1.3	0.0	0.0	1.2	…	1.0

[a] Includes all 7 sites (25 million population) under surveillance in 1999.

Overall, 66% of the reports had complete race/ethnicity data. The adjusted annual average incidences by race/ethnicity were 2.8 cases/100,000 population among Hispanics, 1.9 cases/100,000 population among whites and blacks, 1.1 cases/100,000 population among Asians/Pacific Islanders, and 0.6 cases/100,000 population among American Indians. Although substantial and progressive decreases in the incidence of SE infection during 1996–1999 occurred among whites (50%), Hispanics (46%), and blacks (40%), infection rates changed little in the other 2 groups (table 2). The number of cases of SE infection peaked in the summer months throughout the study period, and the decrease from 1996 to 1999 occurred in all months of the year.

An average of 17% of infected persons were hospitalized each year: 17% in 1996 and 1997, 15% in 1998, and 19% in 1999. Hospitalization rates by year varied widely between and within states, from 25% in California in 1996 to 7% in Oregon in 1998. The percentage of infected persons who were hospitalized was highest in the youngest and oldest age groups, peaking at

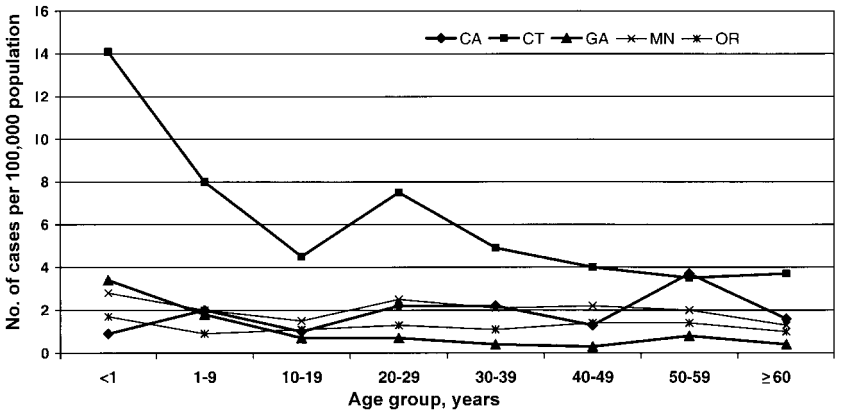

Figure 1. Four-year average incidences of *Salmonella* serotype Enteritidis infection, by age group and site, FoodNet, 1996–1999

24% among infants and 36% among persons aged ⩾60 years (figure 2). Because 2 persons with SE infection died during the study period, the case-fatality rate was 0.2%.

Data from 1999. In 1999, there were 419 cases of SE infection identified in the 7 FoodNet sites in combination, which meant that the incidence was 1.6 cases/100,000 population. This rate was 19% higher than the 1.3 cases/100,000 population in the 5 original sites in 1999. The lowest and highest incidence rates were in Georgia (0.7 cases/100,000 population) and Maryland (4.2 cases/100,000 population) (table 2). In 1999, average sex- and age-specific rates were higher in the 7 sites than in the 5 original sites. The difference in rates was most pronounced among infants (6.5 vs. 3.0 cases/100,000 population). Rates among children aged <10 years and persons aged >40 years were highest in Maryland. Expanding the catchment area had a substantial influence on rates of infection by race/ethnicity. The rate among blacks in Maryland in 1999 was 56.7 cases/100,000 population, with the addition of Maryland; therefore, blacks (with 2.4 cases/100,000 population) replaced Hispanics (with 1.9 cases/100,000 population) as the group with the highest rate of infection (table 2).

DISCUSSION

SE infection rates varied widely among the FoodNet sites. These regional variations, which have been apparent in the National *Salmonella* Surveillance System since the 1980s, contrast with overall *Salmonella* rates, which exhibit less regional variation (figure 3) [4]. Exploring these regional differences is essential to understanding the factors that have contributed to the overall decrease in rates of infection.

From 1996 to 1999, the incidence of SE infection in the 5 original FoodNet sites decreased by 46%. This decrease occurred in 4 of 5 FoodNet sites, with the most marked decrease in the sites that had the highest baseline incidence in 1996. Georgia was the only FoodNet site where the SE infection rate increased. Possible explanations for the increase may be related to increases in serotyping at the state laboratory. The rate of

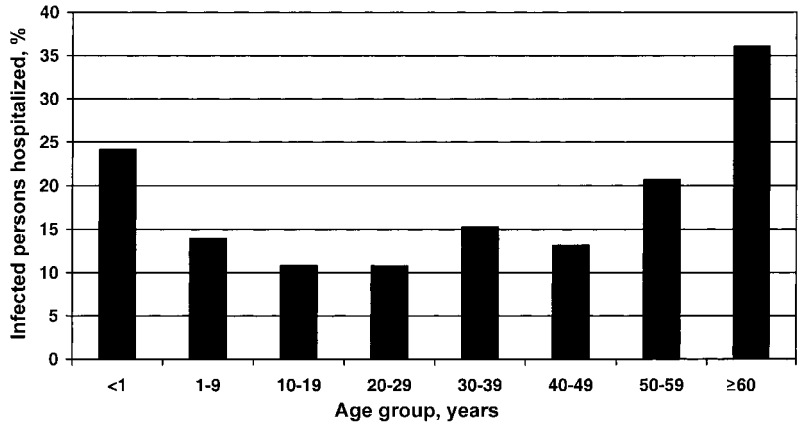

Figure 2. Four-year average percentage of persons with *Salmonella* serotype Enteritidis infection who were hospitalized, by age group, FoodNet, 1996–1999.

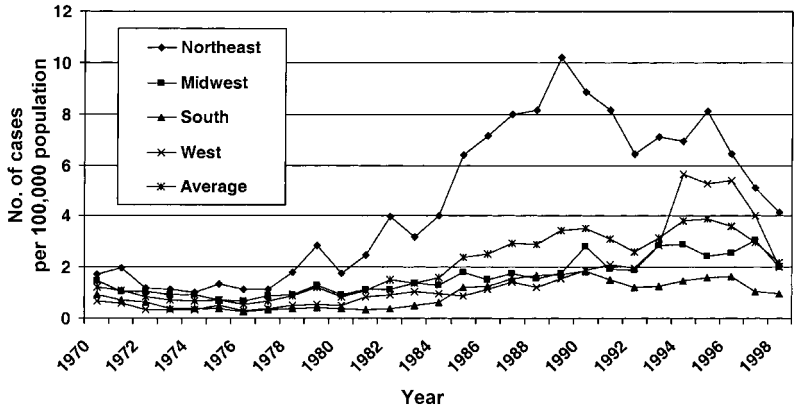

Figure 3. Incidence of infection with *Salmonella* serotype Enteritidis, by region and year, United States, 1970–1998

SE infection in Georgia was stable from 1996 to 1998 but increased in 1999. During the same time period (1996–1999), the number of *Salmonella* isolates that were serotyped in Georgia increased steadily. This increase in serotyping does not, however, entirely explain the increase in SE infection in Georgia from 1998 to 1999, because the number of all infections caused by *Salmonella* species increased by 23%. This increase may have occurred because, in 1996, Georgia had not yet been affected by the outbreak of SE infection that affected the United States. The reasons for this statewide change warrant further examination.

To determine why the incidence of SE infection decreased in the FoodNet sites, one must examine the risk factors for infection. The most common food source implicated in SE infection outbreaks is shell eggs [6, 9–12]. Of the 360 outbreaks of SE infection with a confirmed source reported during 1985–1998 to the CDC, 279 (78%) were associated with raw or undercooked shell eggs [6]. Less is known about the risk factors for sporadic SE infection. In a case-control study of sporadic SE infection in Minnesota, Hedberg et al. [13] found that risk for such infections was associated with eating undercooked eggs or egg-containing foods. Similar findings were reported from case-control studies conducted in California [14], New York [11], Wisconsin [15], and Trinidad and Tobago [16]. In a FoodNet case-control study of SE infection that was conducted in 1996–1997, international travel and the consumption of chicken prepared outside the home were found to be significant risk factors for infection [17].

Several factors, including on-farm control measures, use of refrigeration, and consumer and food-service worker education, may be contributing to the decrease in SE infection rates [6, 18, 19]. Changes in on-farm control measures include the implementation of egg traceback investigations and quality assurance programs. When eggs are implicated in an outbreak of SE infection, state health departments or FDA officials can conduct a traceback investigation to identify the source of the eggs and ensure that infected eggs from that source are sent to pasteurization facilities. The fact that quality assurance programs were first implemented in the northeastern states may, in part, account for the significant reduction in rates of SE infection in Connecticut and other FoodNet sites [6].

Insisting on proper refrigeration is a means of reducing rates of SE infection. Since 1998, the Food Safety and Inspection Service has required that shell eggs be stored and transported at ≤45°F and that consumer containers carry labels indicating that refrigeration is required [19].

If the consumption of chicken is a risk factor for SE infection, the measures taken to reduce SE contamination among chickens probably contributed to the decrease in SE infection rates. These measures also probably contributed to the modest decrease in the rate of *Campylobacter* infection [20]. A review of data on nonhuman isolates and the prevalence of flock infections may help determine whether the efforts being made in egg and chicken safety are truly influencing the rate of human infection.

The incidence of SE infections in FoodNet surveillance areas was somewhat lower than the nationwide estimates of the National *Salmonella* Surveillance System, which probably reflects an underrepresentation in FoodNet of states with a high incidence of SE infection. However, both surveillance systems indicated similar decreases in incidence during 1996–1999. The national reported rate of isolation of SE was 3.61 cases/100,000 population in 1996 and 1.96 cases/100,000 population in 1999, a decrease of 46% [21]. The consistencies of these decreases suggest that FoodNet surveillance is capturing a general, rather than a local, effect.

Of note is the change in SE infection rates after the expansion of the FoodNet catchment area. The increase in rates with the addition of Maryland and New York is not surprising, given the dramatic variations in rates among the original 5 sites. The epidemiology of SE infection appears to have been different in each area, with higher SE infection rates among blacks in Mar-

yland and Connecticut but not in the other sites. Rates among infants were particularly high in Maryland, Connecticut, and New York. These regional variations should continue to be monitored. The larger FoodNet catchment area (29.5 million persons, or 10.8% of the United States population in 2000) will allow for better estimates of the true burden of SE infection in the country and will provide the opportunity to monitor trends over time.

The recent dramatic decrease in rates of SE infection is encouraging; however, better prevention efforts on farms and in the production and distribution of eggs and chickens are needed, as are better methods of monitoring of these prevention efforts. The use of approved technology, such as the pasteurization of shell eggs and irradiation of poultry, may prove to be important in efforts to further reduce the rate of SE infections.

FOODNET WORKING GROUP MEMBERS

CDC: Frederick Angulo, Timothy Barrett, Michael Beach, Nancy Bean, Richard Bishop, Thomas Boyce, Laura Conn, Vance Dietz, Mary Evans, Cindy Friedman, Kate Glynn, Patricia Griffin, John Hatmaker, Peggy Hayes, Debra Helfrick, Thomas Hennessy, Mike Hoekstra, Lori Hutwagner, Beth Imhoff, Malinda Kennedy, Deborah Levy, Bill MacKenzie, Kathleen Maloney, Nina Marano, Paul Mead, Thomas Navin, Sarah Pichette, Robert Pinner, Sudha Reddy, Laurence Slutsker, Karen Stamey, Bala Swaminathan, David Swerdlow, Robert Tauxe, Thomas Van Gilder, Drew Voetsch, David Wallace, Stephanie Wong, and Samantha Yang Rowe. California: Sharon Abbott, Felicia Chi, Pam Daily, Marianne David, Mary Ann Davis, Lisa Gelling, Alexander McNees, Janet Mohle-Boetani, Nandeeni Mukerjee, Joelle Nadle, Jan O'Connell, Judy Rees, Kevin Reilly, Art Reingold, Gretchen Rothrock, Michael Samuel, Sue Shallow, Ben Silk, Duc Vugia, Stephen Waterman, and Ben Werner. Connecticut: Gary Budnick, Matthew Carter, Terry Rabatsky-Ehr, James Hadler, Robert Howard, Gazala Kazi, Aristea Kinney, Ruthanne Marcus, Donald Mayo, Patricia Mshar, Randall Nelson, Quyen Phan, Robin Ryder, and Charles Welles. Georgia: Sabrina Burden, Molly Bardsley, Wendy Baughman, Paul Blake, Shama Desai, Monica Farley, Katherine Gibbs-McCombs, Laura Gilbert, Jane Koehler, Mina Pattani, Susan Ray, Matthew Sattah, Suzanne Segler, Kathleen Toomey, and Sabrina Whitfield. Maryland: Bernadette Albanese, Lillian Billman, Alicia Bustamante, Amy Carnahan, Michael Carter, Marcia Criscio, Yvonne Deane-Hibbert, Diane Dwyer, Lora Gay, Althea Glenn, Charmaine Gregg, Lee Harrison, Kelly Henning, Yvonne Hibbert, Kim Holmes, Jackie Hunter, Judith Johnson, Tobi Karchmer, Melissa Kent, J. Glenn Morris Jr., Lola Olabode, Peggy Pass, Jafar Razeq, Jeffery Roche, Dale Rohn, Christine St. Ours, Christian Steiner, Alexander Sulakvelidze, Frances Yarber, and Yongyu Wang. Minnesota: Jeff Bender, John Besser, Richard Danila, Valerie Deneen, Craig Hedberg, Julie Hogan, Heidi Kassenborg, Carlota Medus, Michael Osterholm, Kirk Smith, Dana Soderlund, and Julie Wicklund. New York: Bridget Anderson, Dianna Bopp, Hwa-Gan Chang, Kathy Carlton, Barbara Damaske, Nellie Dumas, Marie Fitzgerald, Karim Hechemy, Jonathan Hibbs, Julia Kiehlbauch, Dale Morse, Candace Noonan, Brian Sauders, Perry Smith, Nancy Spina, Cathy Stone, and Shelley Zansky. Oregon: Vijay Balan, Chris Biggs, Maureen Cassidy, Paul Cieslak, Emilio DeBess, David Fleming, Bill Keene, Stephen Ladd-Wilson, Lore Lee, Eileen Lorber, Steve Mauvais, Teresa McGivern, Beletshachew Shiferaw, Bob Sokolow, Regina Stanton, and John Townes. Tennessee: Brenda Barnes, Effie Boothe, Allen Craig, Diane Eigsti Gerber, Timothy Jones, William Moore, William Schaffner, and Pat Turri. US Department of Agriculture, Food Safety Inspection Service: Arthur Baker, Ruth Etzel, Jill Hollingsworth, Peggy Nunnery, Phyllis Sparling, and Kaye Wachsmuth. US Food and Drug Administration, Center for Food Safety and Applied Nutrition: Sean Alterkruse, Ken Falci, Bing Garthright, Janice Oliver, and Clifford Purdy.

References

1. Centers for Disease Control and Prevention. Incidence of foodborne illnesses—FoodNet, 1997. MMWR Morb Mortal Wkly Rep **1998**; 47: 782–6.
2. Centers for Disease Control and Prevention. Incidence of foodborne illnesses: preliminary data from the Foodborne Diseases Active Surveillance Network (FoodNet)—United States, 1998. MMWR Morb Mortal Wkly Rep **1999**; 48:189–94.
3. Centers for Disease Control and Prevention. Preliminary FoodNet data on the incidence of foodborne illnesses—selected sites, United States, 1999. MMWR Morb Mortal Wkly Rep **2000**; 49:201–5.
4. Olsen SJ, Bishop R, Brenner FW, et al. The changing epidemiology of *Salmonella:* trends in serotypes isolated from humans in the United States, 1987–1997. J Infect Dis **2001**; 183:753–61.
5. Angulo FJ, Swerdlow DL. *Salmonella enteritidis* infections in the United States. J Am Vet Med Assoc **1998**; 213:1729–31.
6. Centers for Disease Control and Prevention. Outbreaks of *Salmonella* serotype Enteritidis infection associated with eating raw or undercooked shell eggs—United States, 1996–1998. MMWR Morb Mortal Wkly Rep **2000**; 49:73–9.
7. Angulo FJ, Voetsch AC, Vugia D, et al. Determining the burden of human illness from foodborne diseases. Vet Clin North Am Food Anim Pract **1998**; 14:165–72.
8. Brenner FW, Villar RG, Angulo FJ, Tauxe R, Swaminathan B. *Salmonella* nomenclature. J Clin Microbiol **2000**; 38:2465–7.
9. St. Louis ME, Morse DL, Potter ME, et al. The emergence of grade A eggs as a major source of *Salmonella enteritidis* infections. JAMA **1988**; 259:2103–7.
10. Mishu B, Griffin PM, Tauxe RV, Cameron DN, Hutcheson RH, Schaffner W. *Salmonella enteritidis* gastroenteritis transmitted by intact chicken eggs. Ann Intern Med **1991**; 115:190–4.
11. Morse DL, Birkhead GS, Guardino J, Kondracki SF, Guzewich JJ. Outbreak and sporadic egg-associated cases of *Salmonella enteritidis:* New York's experience. Am J Public Health **1994**; 84:859–60.
12. Mohle-Boetani JC, Werner SB, Abbott S, et al. *Salmonella enteritidis* infections from shell eggs: outbreaks in California. West J Med **1998**; 169:299–301.
13. Hedberg CW, David MJ, White KE, MacDonald KL, Osterholm MT.

Role of egg consumption in sporadic *Salmonella enteritidis* and *Salmonella typhimurium* infections in Minnesota. J Infect Dis **1993**; 167: 107–11.

14. Passaro DJ, Reporter R, Mascola L, et al. Epidemic *Salmonella enteritidis* infection in Los Angeles County, California: the predominance of phage type 4. West J Med **1996**; 165:126–30.
15. Trepka MJ, Archer JR, Altekruse SF, Proctor ME, Davis JP. An increase in sporadic and outbreak-associated *Salmonella* Enteritidis infections in Wisconsin: the role of eggs. J Infect Dis **1999**; 180:1214–9.
16. Indar-Harrinauth L, Daniels N, Prabhakar P, et al. Emergence of *Salmonella enteritidis* phage type 4 in the Caribbean: case-control study in Trinidad and Tobago, West Indies. Clin Infect Dis **2001**; 32:890–6.
17. Kimura AC, Reddy V, Marcus R, et al. Chicken consumption is a newly identified risk factor for sporadic *Salmonella enterica* serotype Enteritidis infections in the United States: a case-control study in FoodNet sites. Clin Infect Dis **2002**;38(Suppl 3):S244–52 (in this issue).
18. US Department of Agriculture, Animal and Plant Health Inspection Service. Code of Federal Regulations. 9 CFR Parts 71 and 82. Chickens affected by *Salmonella* Enteritidis: final rule. Washington, DC: US Government Printing Office, **1991**:3730–42.
19. Food Safety Inspection Service. Refrigeration and labeling requirements for shell eggs: final rule. Federal Register **1998**; 63:45663–75.
20. Samuel M, Vugia D, Shallow S, et al. Epidemiology of sporadic *Campylobacter* infection in the United States and declining trend in incidence, FoodNet 1996–1999. Clin Infect Dis **2002**; 38(Suppl 3):S165–74 (in this issue).
21. Centers for Disease Control and Prevention. *Salmonella* surveillance: annual tabulation summary, 1999. Atlanta: US Department of Health and Human Services, **2000**.